



Fingerprinting Merit Badge

**“Fingerprints cannot lie,
but liars can make fingerprints.”**

—Unknown

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Fingerprinting Merit Badge Requirements



1. Give a short history of fingerprinting. Tell the difference between civil and criminal identification.
2. Explain the difference between the automated fingerprint identification systems (AFIS) now used by some law enforcement agencies and the biometric fingerprint systems used to control access to places like buildings, airports, and computer rooms.
3. Do the following:
 - a. Name the surfaces of the body where friction or papillary ridges are found.
 - b. Name the two basic principles supporting the science of fingerprints and give a brief explanation of each principle.
 - c. Explain what it takes to positively identify a person using fingerprints.



Fingerprinting Merit Badge Requirements



4. Take a clear set of prints using ONE of the following methods.
 - a. Make both rolled and plain impressions. Make these on an 8-by-8-inch fingerprint identification card, available from your local police department or your counselor.
 - b. Using clear adhesive tape, a pencil, and plain paper, record your own fingerprints or those of another person.
5. Show your merit badge counselor you can identify the three basic types of fingerprint patterns and their subcategories. Using your own hand, identify the types of patterns you see.



Fingerprinting Merit Badge





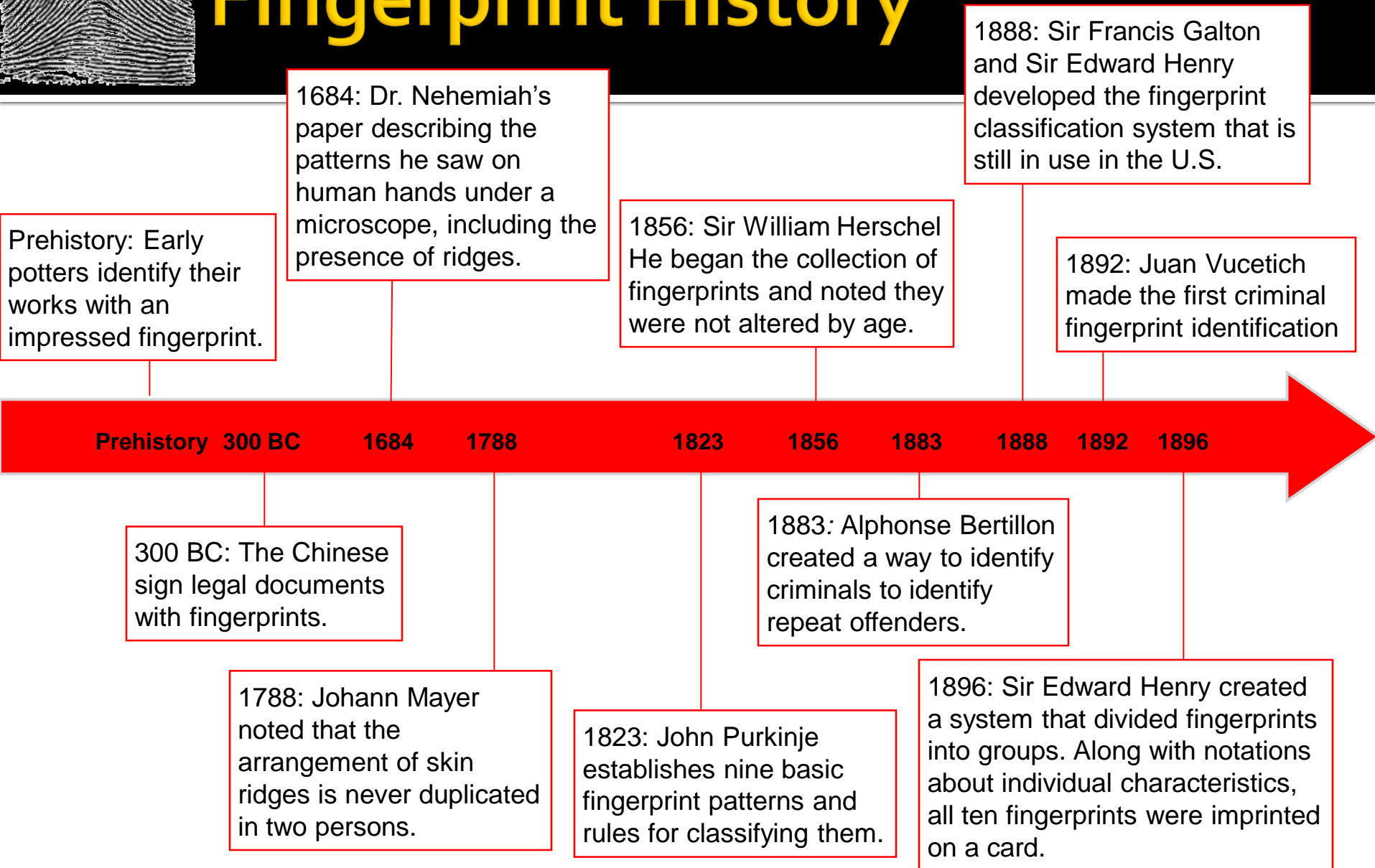
Requirement #1



Give a short history of fingerprinting. Tell the difference between civil and criminal identification.



Fingerprint History





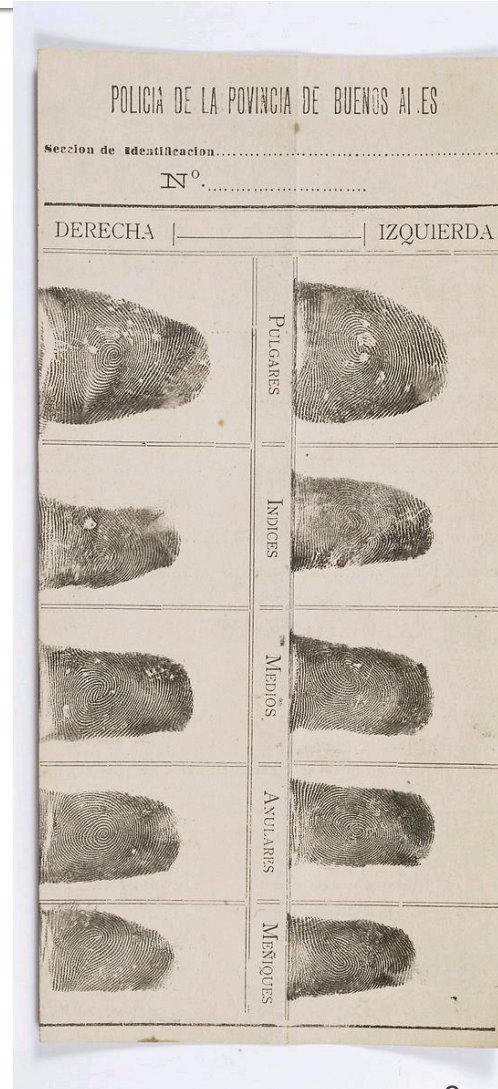
Juan Vucetich's Early Fingerprints

- In 1892, two boys were brutally murdered in the village of Necochea, near Buenos Aires, Argentina.
- Initially, suspicion fell on a man named Velasquez, a suitor of the children's mother, Francisca Rojas.
- Even after torture, the police could not get him to confess.
- Investigators found a bloody fingerprint at the crime scene and contacted Juan Vucetich, who was developing a system of fingerprint identification for police use.
- Vucetich compared the fingerprints of Rojas and Velasquez with the bloody fingerprint.



Juan Vucetich's Early Fingerprints

- Francisca Rojas had denied touching the bloody bodies, but the fingerprint matched one of hers.
- Confronted with the evidence, she confessed—the first successful use of fingerprint identification in a murder investigation.
- After the Rojas case, Vucetich improved his fingerprint system, which he called "comparative dactyloscopy."
- Adopted by the province of Buenos Aires in 1903, it spread rapidly throughout the Spanish-speaking world.





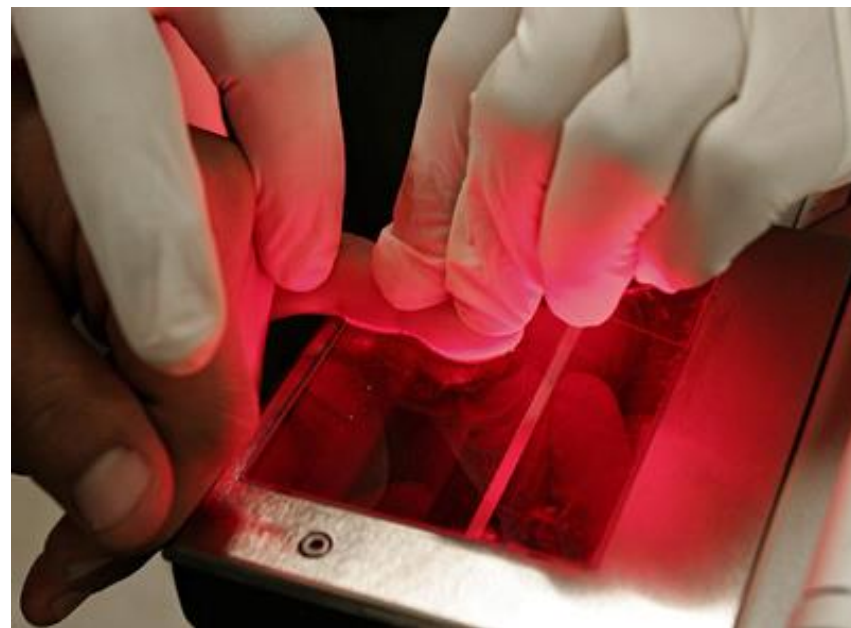
An Early Example of a Ten Card

NAME William G. Linderman	IDENTIFICATION NO. 63893	1913	INDEX FINGER CLASSIFICATION R1 X 2 1/2 19	THUMB 1				
REGISTERED BY POWERS	AS S. A.	DATE 11/17/13	7/27					
CLASSIFICATION BY E. S. PARKS	DATE NOV 25 1913	NOV 24 11 33 21						
TESTED BY	DATE	First Length	First Width	Second Length	Ear First	Ear Color	Height	Age
		18.9	15.3	12.6	27.7	50.1	80.4	27
RIGHT HAND								
LEFT HAND								
LEFT HAND			THUMB		THUMB		RIGHT HAND	



Civil vs. Criminal Fingerprint Identification

- Civil fingerprints are mostly of individuals who have served or are serving in the U.S. military or have been or are employed by the federal government.
- In the United States, the FBI manages a fingerprint identification system and database which holds the fingerprints of criminal record subjects





Requirement #2



Explain the difference between the automated fingerprint identification systems (AFIS) now used by some law enforcement agencies and the biometric fingerprint systems used to control access to places like buildings, airports, and computer rooms.



Automated Fingerprint Identification System (AFIS)

- In the early 1970s, the FBI and the National Bureau of Standards conducted feasibility research for establishing an automated fingerprint identification process.
- AFIS allows law enforcement agencies to conduct comparisons of applicant and suspect fingerprints with literally thousands or millions of file prints in a matter of minutes.



Automated Fingerprint Identification System (AFIS)

- AFIS has two major duties
 - First is performing the functions of classifying searching and matching prints
 - Second is the storage and retrieval of fingerprints data
- In July 1999, law enforcement agencies began to have access to the FBI'S Integrated Automated Fingerprint Identification System (IAFIA), a national on-line fingerprint and criminal history database with identification and response capabilities



Automated Fingerprint Identification System (AFIS)



- The local police agency must have a **live-scan fingerprint terminal**.
- The agency may then:
 - Scan an arrestee's prints and mug shots.
 - Electronically transmit the prints, mug shots and personal information to their state's network for fingerprint checks.
- The state agency then transmits the same information to the FBI fingerprint repository for matches.

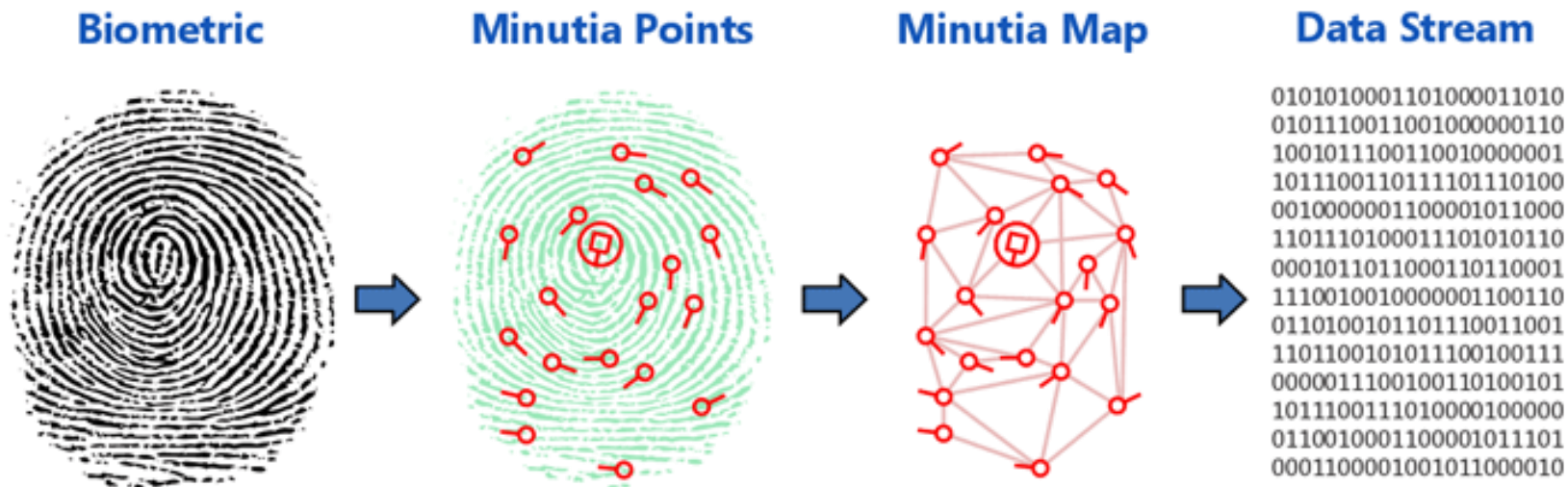


Automated Fingerprint Identification System (AFIS)

- **Capture**: a physical sample is captured by the system during enrollment.
- **Extraction**: unique data is extracted from the sample and a mathematical template is created.
- **Comparison**: the mathematical code is then compared with a new sample.
- **Match/Non-match**: the system then decides if the features extracted from the new sample are a match or a non-match.



Fingerprint Minutia Capture



- Minutia points occur where the lines of the ridges begin, end, branch off and merge with other ridge lines.
- These points are mapped and a line is drawn between each point.
- This creates a map of how each point relates to the other points.
- The map is then stored as a data stream called a minutia template in a database for future comparison with other presented fingerprints.



Fingerprint Minutia Capture

- It is important to note that during the entire process:
 - no fingerprint images are stored on the system.
 - a fingerprint image cannot be recreated from the minutia template.





AFIS Fingerprint Comparison

- Latent prints can be searched against a file of 500,000 prints in one half hour.
- The system produces a list of possibles called a candidate list.
- This list is then checked by a qualified fingerprint examiner.





Biometrics

- Biometrics is the automated method of recognizing a person based on a physiological (i.e. fingerprints) characteristic.
- Biometric technologies are becoming the foundation of highly secure identification and personal verification systems.

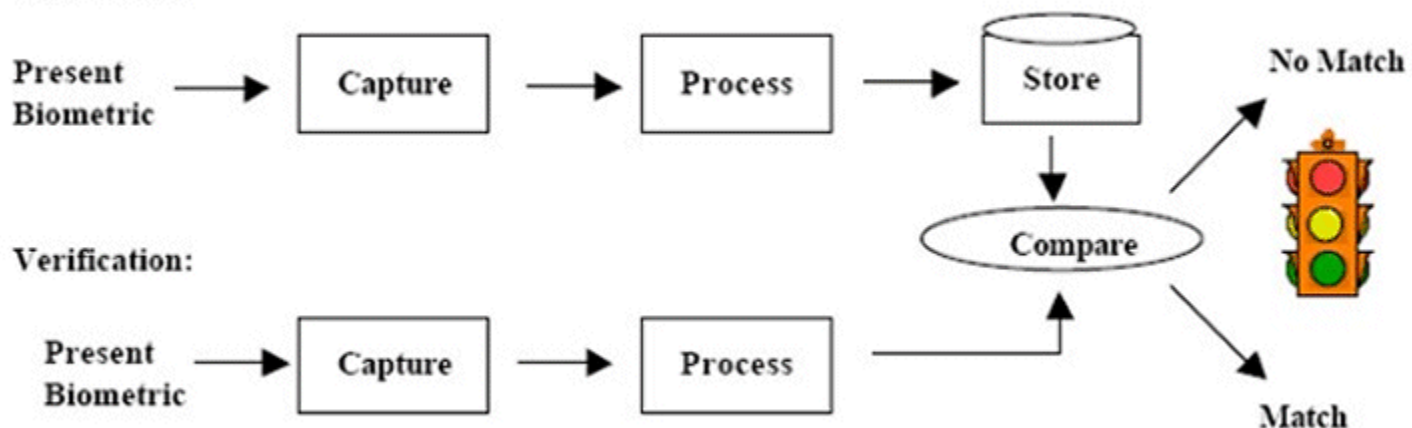




Biometrics

- Biometric authentication requires comparing a stored biometric sample against a newly captured biometric sample (for example, a fingerprint captured during a login).

Enrollment:





Biometrics

- Danger to owners of biometrically secured items.
 - When thieves cannot get access to secure properties, there is a chance that the thieves will stalk and assault the property owner to gain access.
 - For example, in 2005, Malaysian car thieves cut off the finger of a Mercedes-Benz S-Class owner when attempting to steal the car.



Requirement #3



Do the following:

- a. Name the surfaces of the body where friction or papillary ridges are found.
- b. Name the two basic principles supporting the science of fingerprints and give a brief explanation of each principle.
- c. Explain what it takes to positively identify a person using fingerprints.



What Are Fingerprints?

- Friction ridge skin pattern.
- Only found on hairless parts of body such as fingers, palms, toes, and soles of feet.
- Composed of ridges (hills) and furrows (valleys).
- Designed by nature for firmer grip and resistance to slippage.



Black = Ridges
White = Valleys



Other Prints



Palm—friction ridges can be identified and may be used against suspects.



Other Prints

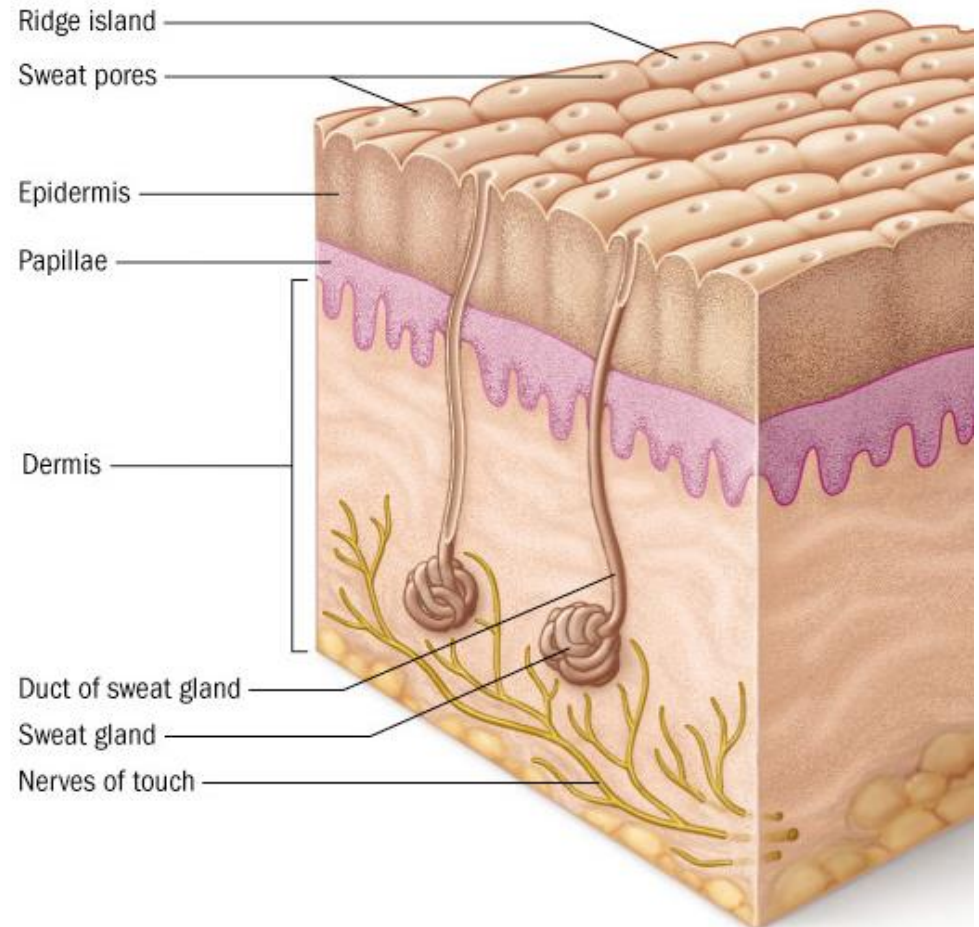
- **Footprints** are taken at birth as a means of identification of infants.





How Are Fingerprints Formed?

- Skin has two layers:
 - Dermis
 - Epidermis
- Between these two are the dermal papillae or basal layer.
- Because the basal layer grows faster, it collapses and folds forming intricate shapes.





First Principal: An Individual's Fingerprints are Unique

- No two people have been found to have the same fingerprints -- they are totally unique.
 - There's a one in 64 billion chance that your fingerprint will match up exactly with someone else's.
- Fingerprints are even more unique than DNA, the genetic material in each of our cells.
 - Although identical twins can share the same DNA -- or at least most of it -- they can't have the same fingerprints.



Second Principal: Fingerprints are Unchanged Through Life

- Fingerprints begin forming by the 10th week of pregnancy.
- Pattern remains unchanged throughout life.



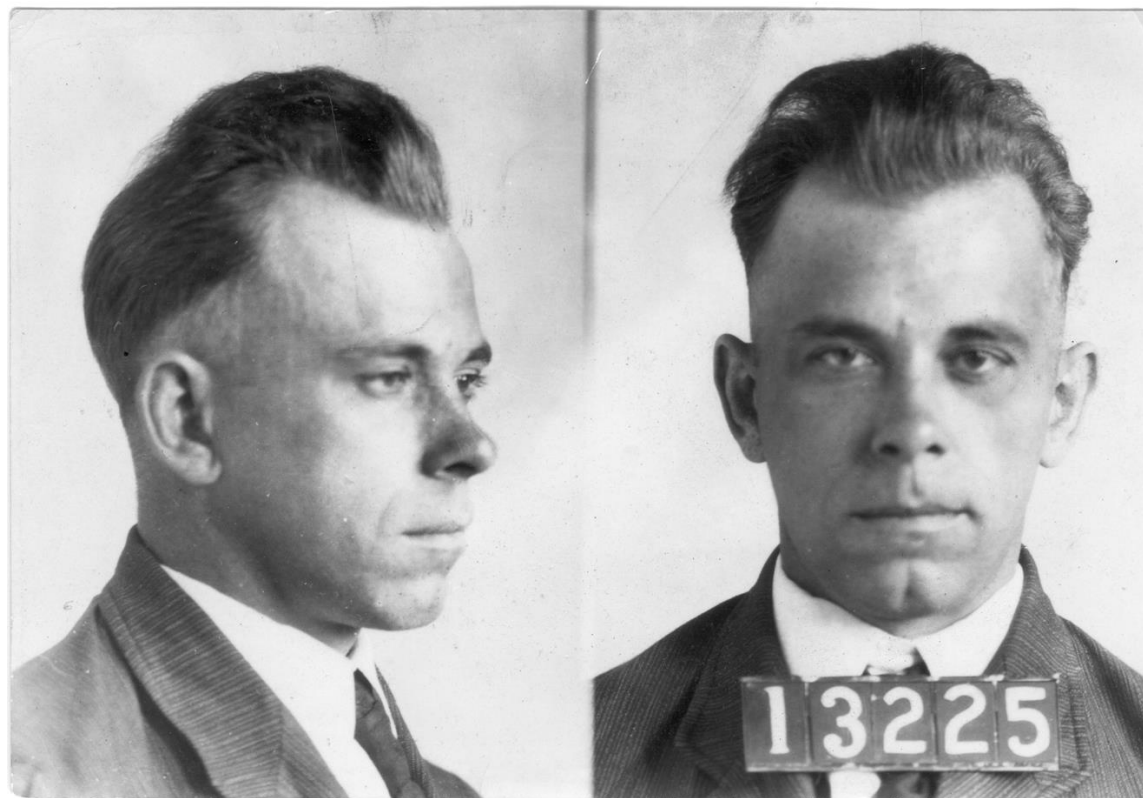


Fingerprints Remain Unchanged

- Impossible to alter, but there has never been a lack of trying.
- To change the pattern requires obliteration of the dermal papillae (1- 2 mm deep).
- Attempts to destroy pattern causes disruption, irreversibly adding more detail!



John Dillinger



The famous American gangster John Dillinger burnt his fingerprints off with acid - but he could have saved himself the intense pain, because they grew back.



Scars

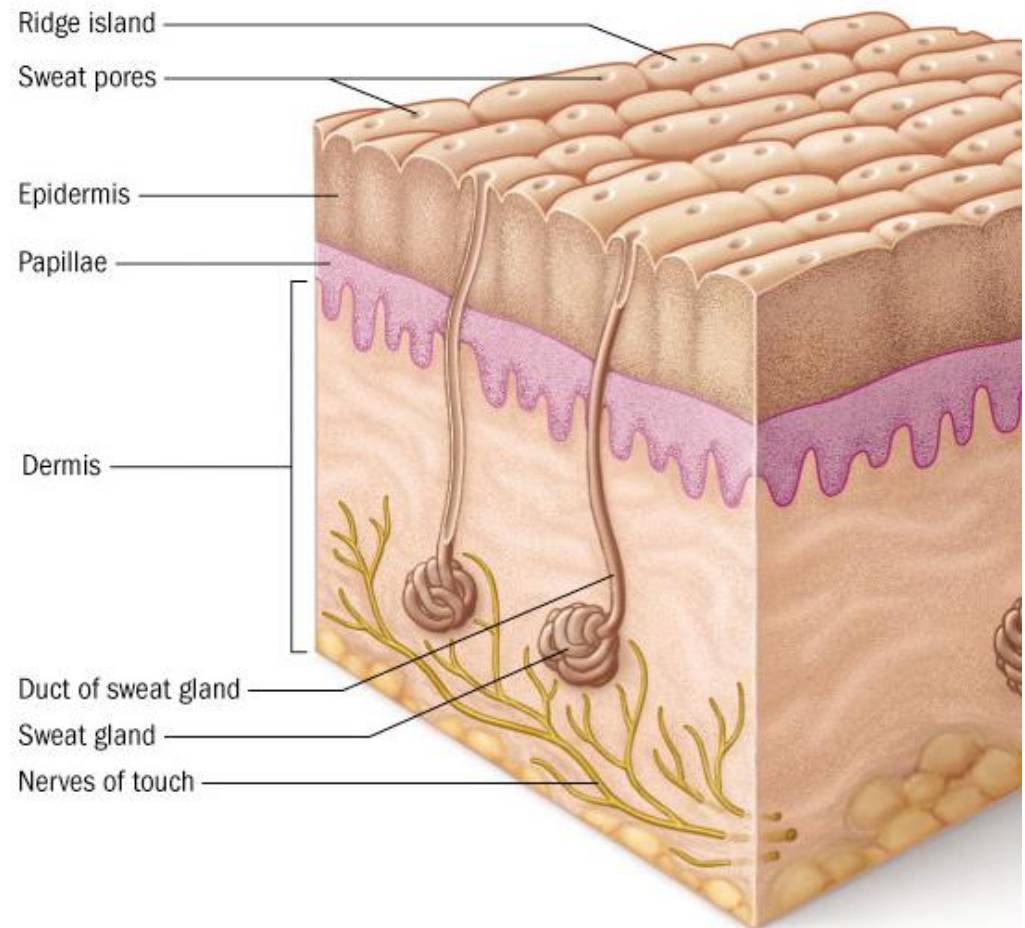


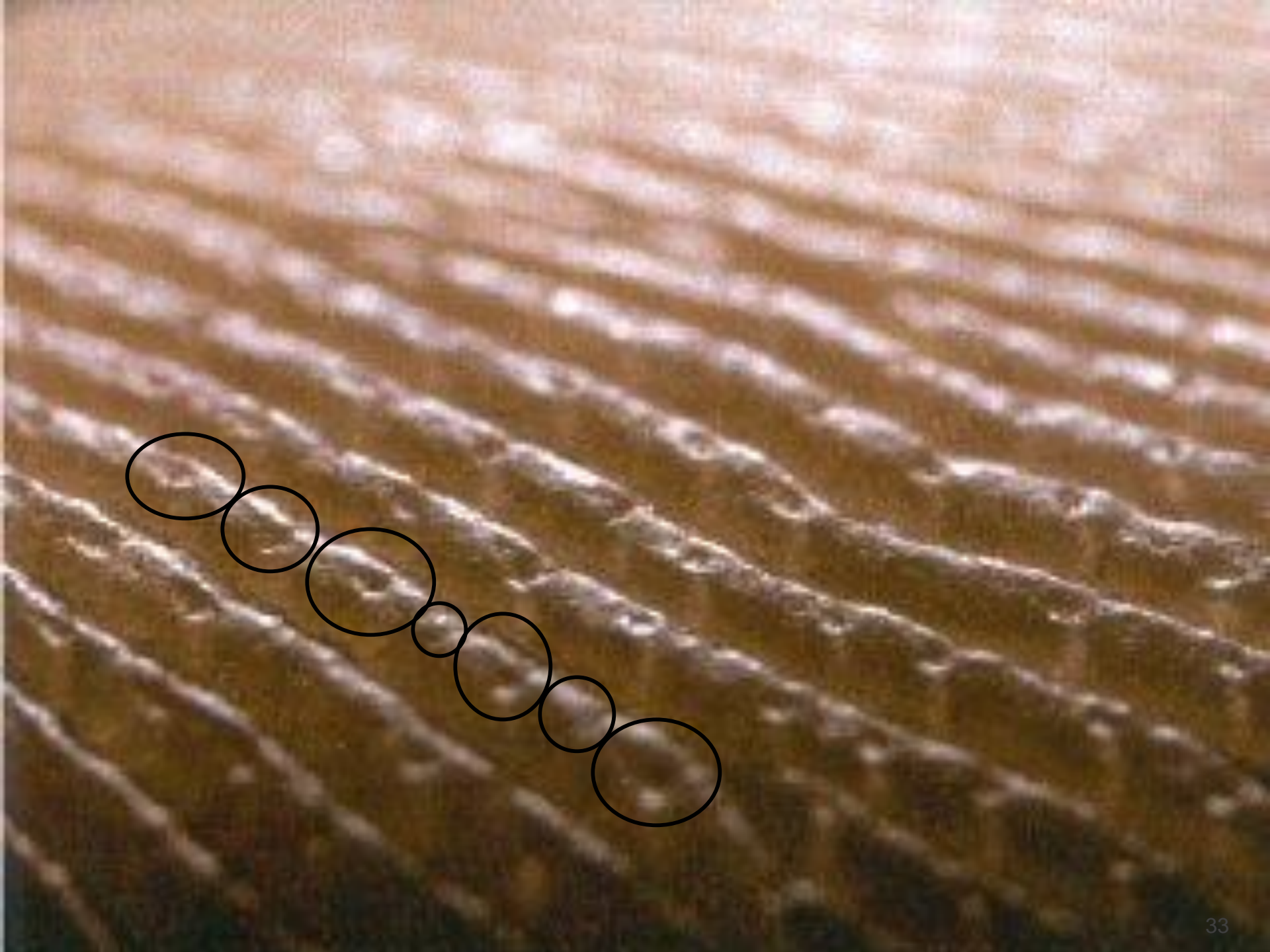
- This permanent scar irreversibly changes the fingerprint.
- It starts near the core of the loop and passes to the right of the screen.



How are Fingerprints Left?

- Each skin ridge is populated by a single row of pores that are openings for ducts leading from the sweat glands.
- Sweat glands secrete sweat to skin surface.
- Sweat is necessary to form latent prints.

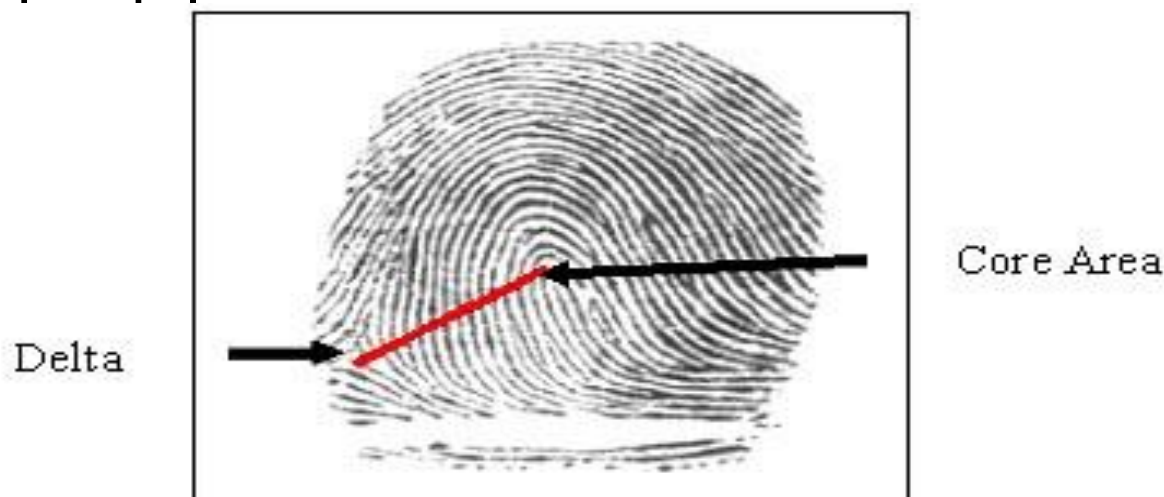






Characteristics of Fingerprints

- Forensic examiners look for the presence of a **core** (the center of a whorl or loop) and **deltas** (triangular regions near a loop).
- A **ridge count** is another characteristic that distinguishes one fingerprint from another. The count is made from the center of the core to the edge of





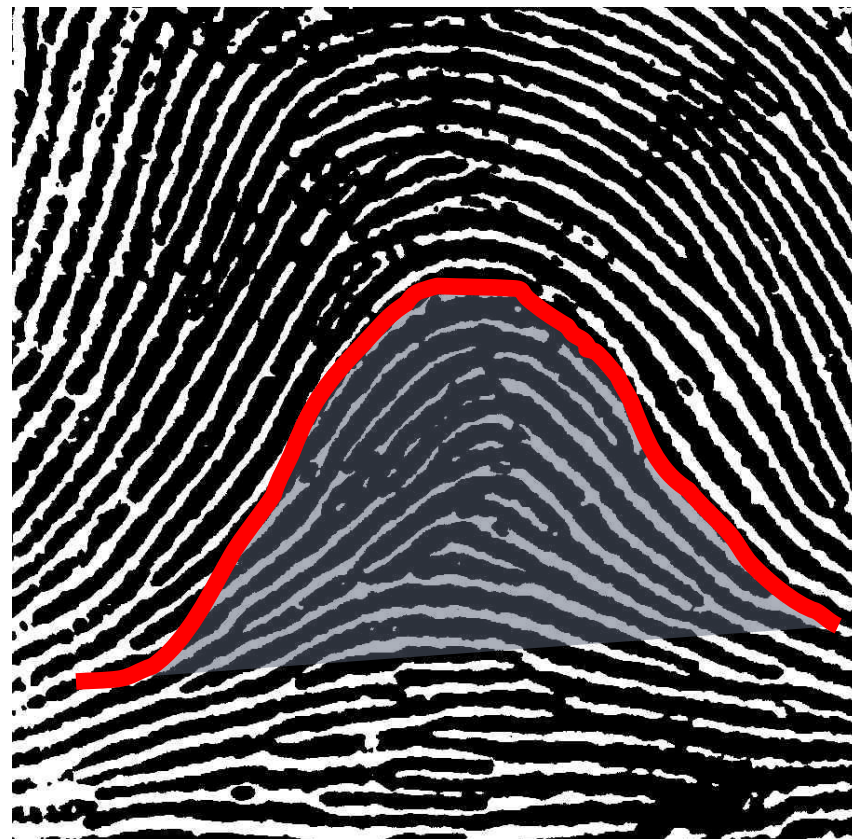
Classification of Fingerprints

- Three basic patterns:
 - **Arches**
 - 5%
 - **Loop**
 - 65%
 - **Whorls**
 - 30%
- Racial variations (African (more arches), European (more loops), Asians/Orientals (more whorls))



Fingerprint Patterns - Arches

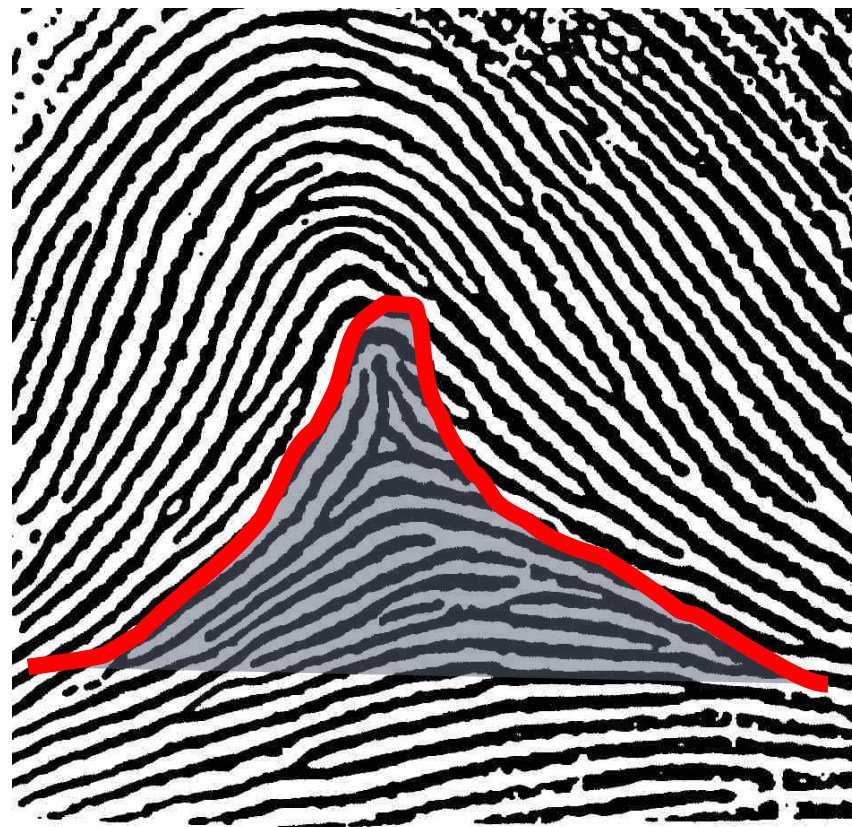
- Arches are ridgelines that rise in the center to create a wavelike pattern.
- They do NOT have deltas or cores.
- Least common of the general patterns of fingerprints.
- Two types of arches: plain (4%), like shown here and...





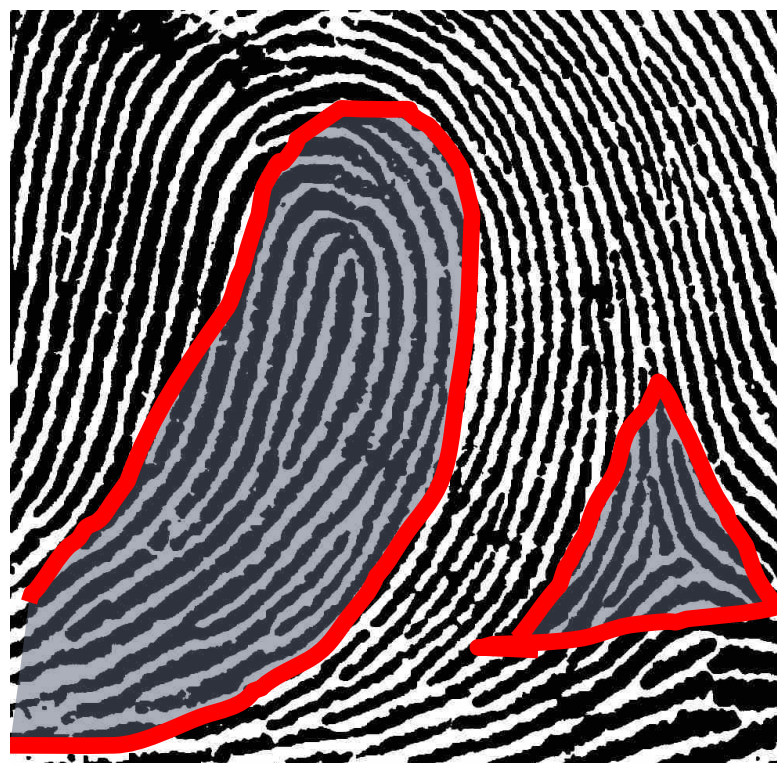
Fingerprint Patterns - Arches

- Tented arch (1%)
- Ends in a sharper point at the center that results in an angle that is less than 90° .





Fingerprint Patterns - Loops



- A loop must have one or more ridges entering and exiting from the same side and one delta (65%).
- Radial loop – loop comes from thumb side of hand.
- Ulnar loop – loop comes from pinkie finger side of hand.



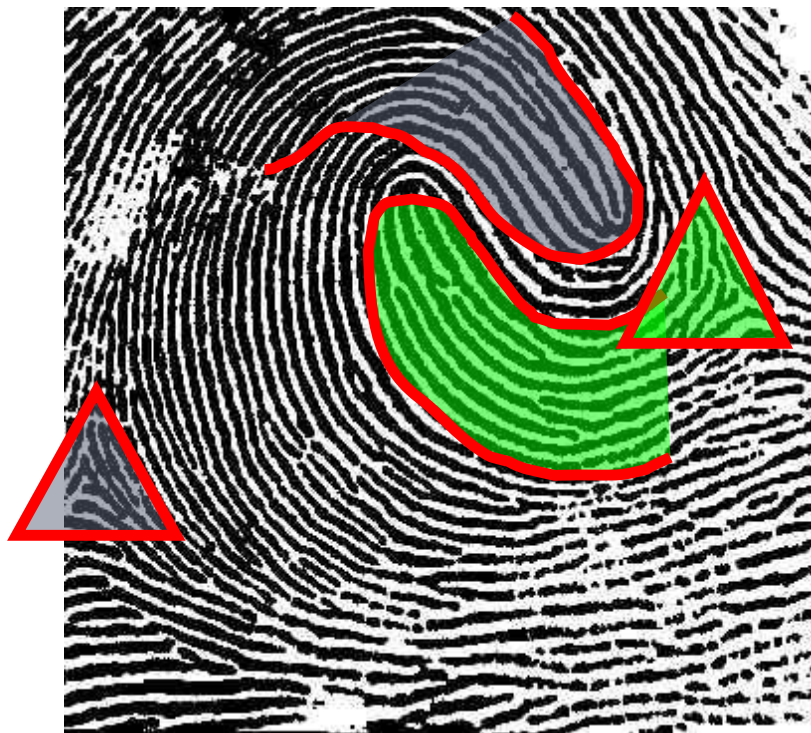
Fingerprint Patterns - Whorls



- Whorls have at least two deltas and a core.
- Divided into four distinct groups.
 - Plain
 - Central Pocket
 - Double Loop
 - Accidental
- This is a plain whorl (24%)



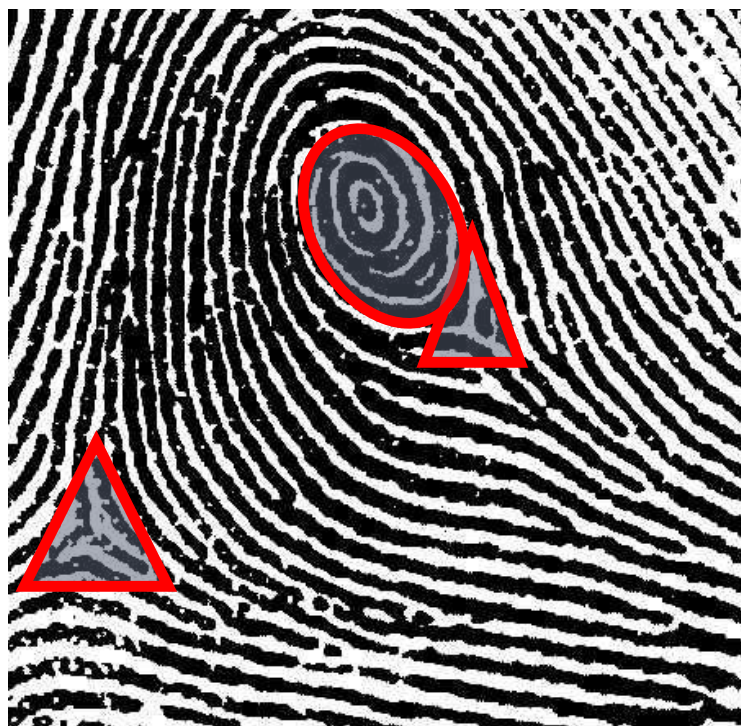
Fingerprint Patterns - Whorls



- Double loop pattern (4%)
- Consists of two separate loop formations, each with its own core, and two deltas.



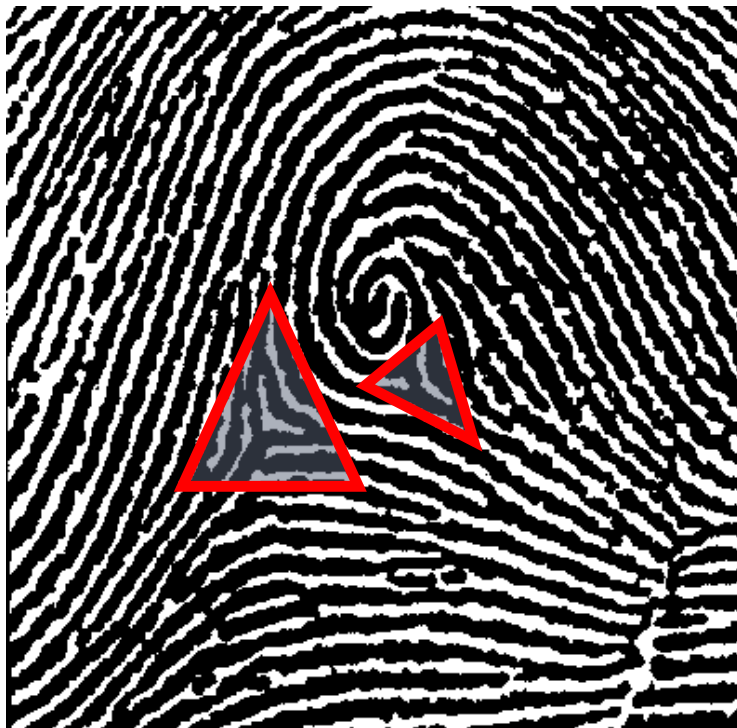
Fingerprint Patterns - Whorls



- Central pocket loop is a combination of loop and whorl (2%).
- It has all the characteristics of a loop, with the addition of a second delta near the core and a whorl-type ridge or ridges circuiting around the core.



Fingerprint Patterns - Whorls



- Accidental pattern will contain two or more deltas that cannot be placed into any of the other classes (0.01%).

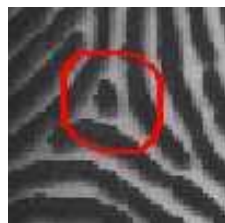


Individualization

- Fingerprints are not only grouped and sub-grouped. They must be individualized.
- Each individual has unique fingerprints. A fingerprint is defined by the uniqueness of the local ridge characteristics and their relationships.
- Minutiae points (aka Galton's details) are the local ridge characteristics.
- Identification points consist of bifurcations, ending ridges, dots, ridges and islands.
- A single rolled fingerprint may have as many as 100 or more identification points that can be used in order to identify the individual.



Island



Dot



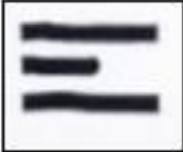











Bifurcation



Ridge Ending

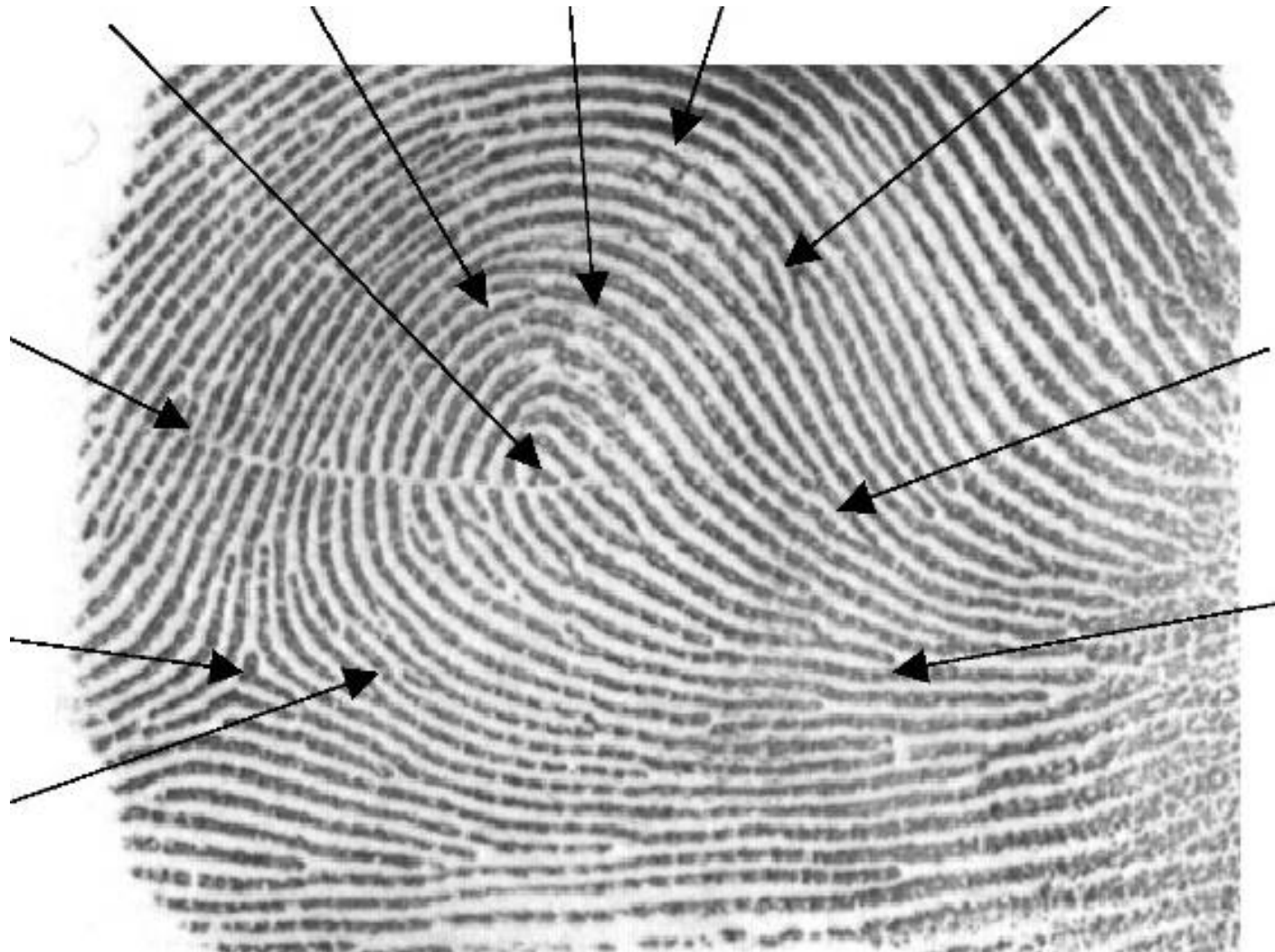


Basic and Composite Ridge Characteristics (Minutiae)

Minutiae	Example	Minutiae	Example
ridge ending		bridge	
bifurcation		double bifurcation	
dot		trifurcation	
island (short ridge)		opposed bifurcations	
lake (enclosure)		ridge crossing	
hook (spur)		opposed bifurcation/ridge ending	

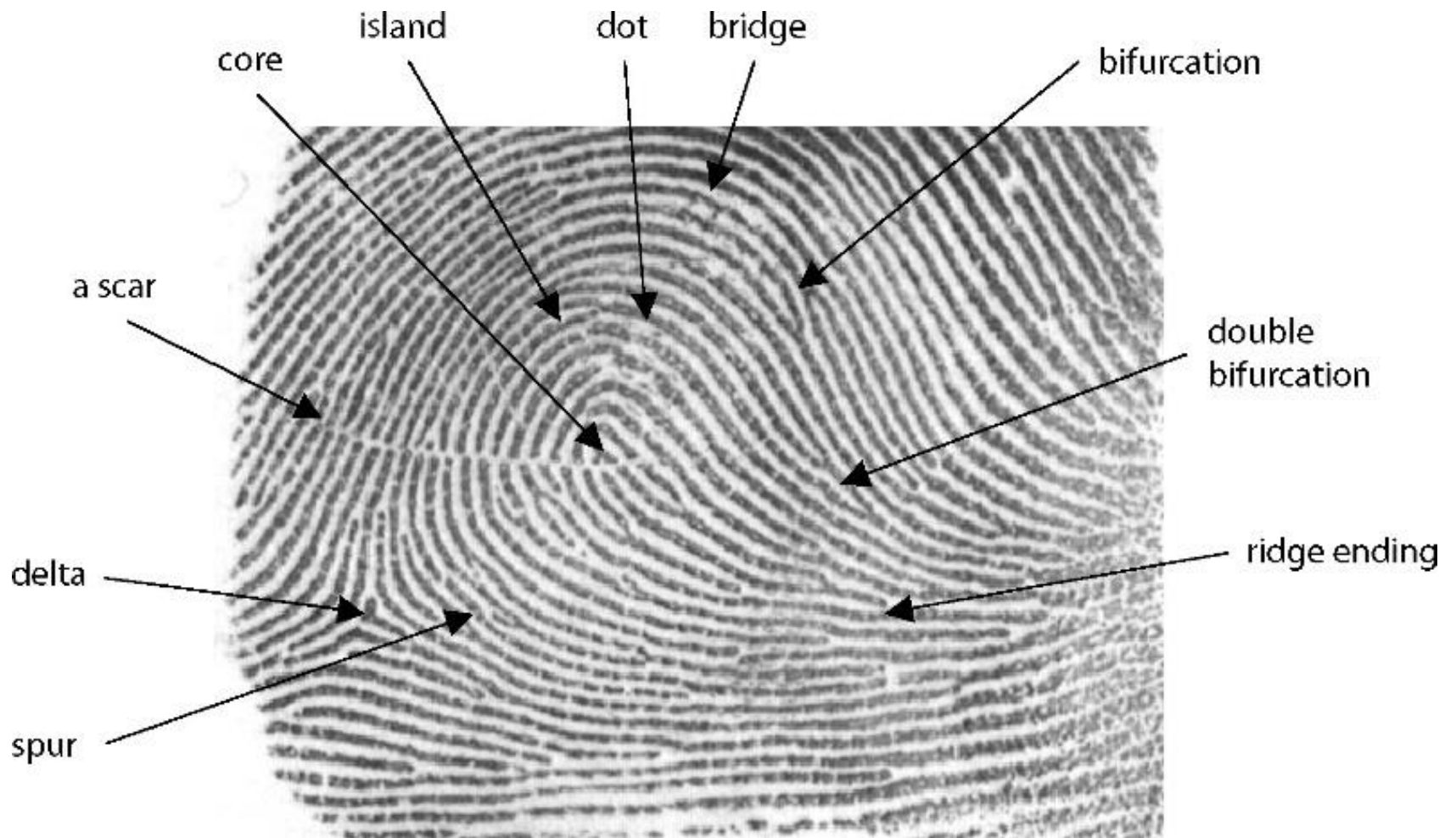


Can You Identify the Fingerprint Minutiae?





Fingerprint Minutiae





Individualization

- Ridge Classification
 - Uses minutiae to individualize fingerprints
 - In U.S. there are no legal requirements for # of points
 - Criminal courts accept 8 to 12 points
 - 150-200 minutiae in a good rolled print
 - Even twins have unique fingerprints due to small differences in the ridge patterns.



Fingerprint Matching Process



- The fingerprint matching process involves looking for identical minutiae in identical locations on each fingerprint.
- These are known as corresponding minutiae.



Fingerprints Are Not Infallible

- Brandon Mayfield is an American lawyer identified as a participant in the Madrid bombing based on a fingerprint match.
- The FBI Latent Print Unit ran the print collected in Madrid and reported a match against one of 20 fingerprint candidates returned in a search response from their IAFIS—Integrated Automated Fingerprint Identification System.
- The FBI initially called the match "100 percent positive" and an "absolutely incontrovertible match".



Brandon Mayfield and the Madrid Bombing

- The Spanish National Police examiners concluded the prints did not match Mayfield, and after two weeks identified another man who matched.
- The FBI acknowledged the error, and a judge released Mayfield after two weeks in May 2004.
- In January of 2006, a U.S. Justice Department report was released which faulted the FBI for sloppy work but exonerated them of more serious allegations.
- The report found that misidentification was due to misapplication of methodology by the examiners involved: Mayfield is an American-born convert to Islam and his wife is an Egyptian immigrant, not factors that affect fingerprint search technology.



Requirements #4 and #5



Requirement #4

- Take a clear set of prints using ONE of the following methods:
 - a. Make both rolled and plain impressions. Make these on an 8-by-8-inch fingerprint identification card available from your local police department or counselor.
 - b. Using clear adhesive tape, a pencil, and plain paper, record your own fingerprints or those of another person.

Requirement #5

- Show your merit badge counselor you can identify the three basic types of fingerprint patterns and their subcategories. Using your own hand, identify the types of patterns you see.



Balloon Prints

- **Materials:** White latex balloons, Fingerprinting pad
- **Procedure**
 1. Partially inflate a balloon. Do not tie it off.
 2. Open fingerprinting pad and gently roll one fingertip.
 3. Apply finger to balloon surface, being careful not to smudge or twist while lifting the finger from the balloon surface.
 4. Inflate balloon enough to view expanded details of the print. Is the print an arch, loop, or whorl?
 5. Examine print for quality and resolution of ridge detail, including minutae.



Inked Prints

- **Materials:** Fingerprinting ink pad, white paper or ten card
- **Procedure**
 1. On a sheet of scrap paper, practice rolling your lab partner's prints.
 2. Cover your partner's finger with a thin coat of ink from the crease at the first knuckle to the very top.
 3. When rolling onto the paper, make one pass in a smooth, even motion. Roll nailbed to nailbed. Do not roll back and forth!
 4. When you feel comfortable with your technique, roll a full set of prints onto the following squares. Be sure that both you and your partner wash your hands before beginning the final version.
 5. Roll each finger, one at a time, onto the inked print data sheet.



Fingerprinting Merit Badge

